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VISUAL EVALUATION OF NYSTAGMUS INTENSITY
IN POINTS TO DIAGNOSE VESTIBULAR DYSFUNCTION

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16. Abstract <p>The amplitude of nystagmus multiplied by its frequency is supposed to give a value commensurate to the velocity of slow phase, one of the most important characteristics. If the amplitude and the frequency during the visual observation are expressed in relative units (e.g. in points range from 1 to 3) the results of multiplication may be used for a relative evaluation of nystagmus intensity.</p> <p>The relative evaluation of nystagmus intensity can be used to compare the responses and, in particular, to calculate the coefficients of labyrinth asymmetry and of directional preponderance. It is suggested to analyse the formal results of caloric tests using a simple graphic model reflecting the left-right interactions by which the obtained coefficients may be conditioned.</p>			
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VISUAL EVALUATION OF NYSTAGMUS INTENSITY IN POINTS
TO DIAGNOSE VESTIBULAR DYSFUNCTION

By M. M. Levashov*

The number of special publications that cover an ever more extensive study /29** of vestibular reactions is rising. A considerable number of them can be classified with experimental nystagmometric studies whose realization requires special equipment. The expediency of such research is quite evident, but in addition it is necessary to continue development of diagnostic procedures that are simple and easily realizable in daily practice.

Two indices that have firmly entered nystagmometry diagnostics, the coefficient of labyrinthine symmetry and the coefficient of directional dominance of nystagmus can be considered the necessary minimum without which the caloric tests have no logical completion. In order to compute the coefficients it is necessary to evaluate the intensity of each reaction. The rate of the slow component (RSC) provides the most accurate idea about the intensity, but in a visual observation it cannot be evaluated, therefore often we are restricted only to determination of the reaction duration. Such a replacement is quite unequivocal, since there is no correlation between the duration of nystagmus and RSC

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(M. M. Levashov, V. D. Rodionov, A. M. Starostenko, 1974).

The task of this report consists of showing a simple method that makes it possible to visually evaluate the intensity of nystagmus to compute the coefficients of labyrinthine asymmetry and directional dominance, as well as approaches that facilitate interpretation of the formal results from the positions of possible pathophysiological concepts.

Nystagmus that is induced by caloric simulation is usually described by the otorhinolaryngologist according to frequency as "rare," "average" and "frequent," and for amplitude—as "small"—, "average"— and "large-scale." The frequency has dimensions of s^{-1} , amplitude—degrees, and their product—degrees/ s^{-1} . This product is close in meaning to the RSC; therefore it can be used for approximate evaluation of intensity. But for this in the process of visual observation it is necessary to introduce the element of quantitative assessment. If a word description is replaced by assessment in points (from 1 to 3), then a real possibility develops for comparing the reactions with the help of relative evaluations of intensity: for example, intensity of nystagmus that is large-scale (3 points) and average in frequency (2 points) will be evaluated as $3 \times 2 = 6$ points.

It remains to stipulate precisely what frequency and amplitude should be evaluated as 2 points, i.e., what one should consider characteristic for nystagmus of average intensity. However, first of all one should solve the question of the interval in whose limit it is necessary to make the visual evaluation of nystagmus, since it is known that the reaction can be fairly lengthy, and each of the characteristics is changed during the reaction, steeply rising to small values and then gradually dropping. It is desirable to make the evaluation

precisely at the section of culmination. The dangers of a too great dispersion of data on these sections seem groundless. Statistical study of the ENG sampling recorded during caloric tests in individuals that do not suffer vestibular dysfunction made it possible to construct samplings of different nystagmus characteristics on sections of the greatest reaction activity. The variation coefficient in the sampling consisting of the average arithmetical frequencies on the culmination sections equalled 24% (in the sampling of average values of the frequency for the entire reaction it equalled 20%); the corresponding coefficients for amplitude were 50% and 46%. Such a slight difference makes it possible to restrict the thorough visual observation to the culmination period. What should one do in order not to miss the culmination during direct observation of nystagmus? Here we again have to return to the norm. Culmination on "normal" ENG was observed in the interval for 30 to 80 s, counting from the beginning of irrigation and directly after it. Here one can limit oneself to 2-3 ten-second periods of observation, and then select the greatest from the results of evaluating intensity.

The specific evaluation in points of frequency and amplitude is the most important. In the study mentioned above the arithmetical average frequency on the culmination section proved to be equal to $2.25 \pm 0.07 \text{ s}^{-1}$. One should practically evaluate the frequency as two points with 19-25 beats in 10 s, and if the frequency is lower or greater, than respectively 1 and 3 points. It is easy to compute the frequency with such values, and if it proves to be higher precise calculation is simply not required, since the evaluation (3 points) is no longer altered. The arithmetical average for the culmination amplitude that "normally" equals 9.38 ± 0.64 (degrees) corresponds to the oscillation of any very noticeable point on the surface of the eyeball or boundary of the

iris and sclera roughly by 2 mm. In this case one can evaluate the amplitude as 2 points. It is convenient to orient oneself on the thickness of a match: the scopes that surpass this size can be evaluated as 3 points, and those that are explicitly lower--1 point.

It is necessary to recall that the reliability of the results depends on how standard the test technique is, and that the numbers presented as the "normal" were obtained with the use of 250 ml of liquid whose temperature differed from the body temperature by 7°C, and irrigation was continued for 40 s. The use of significantly different techniques of caloric tests can require a reexamination of the amounts of characteristics subject to the 2-point evaluation, although nothing basically will be changed. The computation that needs to be made to obtain the coefficient of labyrinthine asymmetry (IA) and directional dominance (DD) is shown by the formulas where a, b, c and d are the intensity of the corresponding nystagmuses.

	Right Ear	Left Ear	
Heat test	a	b	$IA = \frac{(a+c) - (b+d)}{(a+b+c+d)} \times 100 (\%)$
Cold test	c	d	$DD = \frac{(a+d) - (b+c)}{(a+b+c+d)} \times 100 (\%)$

Instead of a certain symbol in evaluating in points one should substitute the product of the points that evaluates the amplitude and frequency.

The difference in intensity of nystagmuses induced during the tests on the right ear (a+c) and on the left ear (b+d) that is expressed in percentages of the sum of all intensities, i.e., the coefficient of labyrinthine asymmetry (IA) indicates how great the difference in activity of the right and left labyrinth is. Asymmetry can be found also in the norm, therefore it is

recommended that those cases where the absolute amount of the coefficient is more than 20% (Kosoy, 1977) be considered pathological in evaluating the nystagmograms. Taking into consideration the lower accuracy of a visual evaluation, this boundary should be raised to 25%. The result with a plus sign is obtained when activity of the right labyrinth dominates (most often as a consequence of suppression of the activity of the left), and the results with the minus sign--with the opposite ratios. The coefficient of directional dominance that is computed by a similar method evaluates the difference between the intensities of the right-and left-directed nystagmuses. The dominance of right-directed reactions yields a result with a plus sign, and left-direction--minus. In contrast to the labyrinthine asymmetry that unequivocally indicates the pathology of the labyrinth or the nerve, directional dominance can be found both during peripheral and during central injuries. A combination of symptoms is not a rarity. In particular, weakening in the activity of one labyrinth often is combined with DD of nystagmus directed towards the healthy side.

Below is the result of using the technique in example of one observation, where the labyrinthine dysfunction was not accompanied by spontaneous nystagmus, and it was only found in an analysis of the set of caloric tests. During heat tests the following was obtained: from the right--large-scale nystagmus with number of beats 20 in a 10-second interval, from the left--small-scale, 19 beats. In the cold test: from the right--average-scale, 22 beats, from the left--small-scale, 26 beats. The results of a point evaluation of intensity: $a=3 \times 2=6$, $b=1 \times 2=2$, $c=2 \times 2=4$, $d=1 \times 3=3$. The coefficients:

$$LA = [(6+4) - (2+3)] : (6+2+4+3) \times 100 = +33\%$$

$$DD = [(6+3) - (2+4)] : (6+2+4+3) \times 100 = +20\%$$

The formal conclusion is "hyporeflexia of the left labyrinth."

One can make a less approximate evaluation by introducing, for example, fractional points for frequency: with number of beats in a 10 second segment up to 17 inclusively--1 point, 18-20 beats--1.5 points, 21-23 beats--2 points, 24-26 beats--2.5 points, and 27 beats and more--3 points.

In the given example with such a refined approach the results are the following:

	Right Ear	Left Ear
Heat Test	3x1.5=4.5	1x1.5=1.5
Cold Test	2x2.0=4.0	1x2.5=2.5

$$LA = [(4.5+4.0)-(1.5+2.5)] : (4.5+1.5+4.0+2.5) \times 100 = +36\%$$

$$DD = [(4.5+2.5)-(1.5+4.0)] : (4.5+1.5+4.0+2.5) \times 100 = +12\%$$

The refined evaluation stressed the importance of LA and reduced the DD.

Under what conditions could precisely such a correlation of intensities be formed? We will present the interrelationships between the right and left vestibular nuclear complexes (NC) in the form of a relatively simple plan (Figure), and will examine them in caloric tests where changes occur in the afferent streams entering the vestibular nerves from the labyrinths. The plan naturally is only a simplified model but it is based on assumptions that do not contradict the facts that are known in experimental and clinical labyrinthology. We will list these assumptions.

1. The intensity of nystagnus (its RSC) in the caloric test depends only on what the absolute amount is for the difference in levels of activity of the right and left vestibular NC at the given moment, and the direction--on its sign.

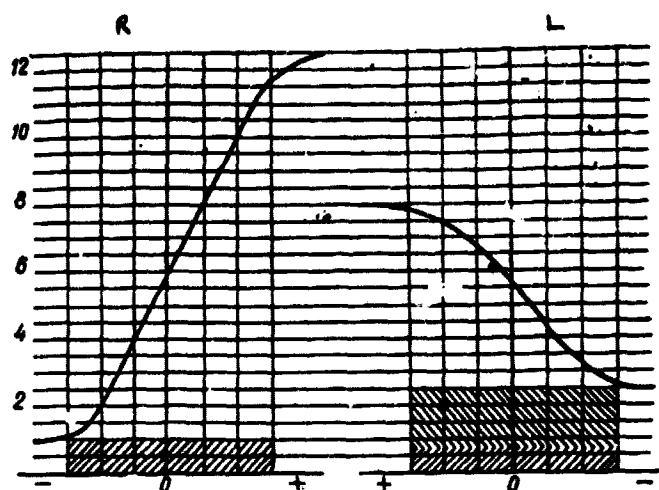


Figure. Plan for Interrelationships of Right (R) and Left (L) Vestibular Complexes During Pathology of Left Labyrinth

Key: on x axis--utriculopetal (+) and utriculofugal (-) cupulo-endolymphatic shifts (relative units)
on y axis--level of activity of nuclear complex formed of natural activity (hatched) and afferent streams entering on VIII nerve (relative units).
Difference in levels R-L during tests roughly corresponds to intensity of nystagmus in points (positive--during nystagmus to the right, negative--to the left).

2. the level of activity of each NC is the sum of the natural activity and the afferent stream entering on the vestibular nerve. The first is altered only on large time segments, and therefore during the test can be considered constant. The afferent stream from the labyrinth outside the test corresponds to a certain stable level of spontaneous impulses, while during the test it is altered only under the influence of cupulo-endolymphatic shifts.

3. the dependence of the change in impulse frequency in the afferent stream on the size of the shift can be represented by a certain S-shaped curve; at the same time during standard caloric tests changes normally occur in the limits of its linear section.

4. during pathology the afferent stream of nerve impulses on the painful side in response to a stimulus is altered differently than on the healthy side. In the given example (Figure) the change in the reactivity of the left labyrinth is expressed in a reduction in the curvature of the characteristic curve, as a consequence of which there was a decrease in the frequency of spontaneous impulses.

5. the decrease in the level of spontaneous impulses is accompanied by a disorder in equilibrium between the summary levels of activity from the right and from the left. In the given example the level of activity from the left proved to be lower than from the right. Without compensation such a difference in the level would result in the appearance of spontaneous nystagmus to the right. However, after changes on the periphery compensation for the disrupted equilibrium occurs, leveling of the activity levels by reinforcing the nuclei in the painful side due to the natural activity of the intact NC. The absence of spontaneous nystagmus is a sign of complete or almost complete compensation.

We will assume that the cupola-endolymphatic shifts that are induced by warmth or cold correspond to two divisions on the x-axis. From the right with such shifts the warmth will induce an increase in impulses over the spontaneous level in the afferent stream roughly by four units on the y-scale, while cold-- a decrease by the same amount. From the left the corresponding increase and decrease will comprise roughly two units. With complete compensation, i.e., with the same levels of summary activity in the right and left NC, the warm and cold nystagmuses from the right would be the same in intensity. However, in our example they differ by 0.5 points. This occurs for the following reason. The intensity of nystagmus depends on the difference in levels, while

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the level of summary activity of the right NC outside the test is somewhat lower than the right, due to insufficiently complete compensation. As a consequence of this conditions are created for the formation of warm nystagmus during the test on the right ear that are somewhat more favorable than for the cold, and its intensity is greater than the intensity governed only by the increase in the afferent stream. The intensity of cold nystagmus from the right was correspondingly reduced by the same amount. Analogous reasons govern the difference in intensities of warm and cold nystagmus from the left; at the same time, on the contrary, the warm nystagmus is less intensive here.

Thus, calculation of nystagmus intensity during a set of caloric tests is a source of valuable diagnostic information; at the same time in order to evaluate intensity one can use a visual observation, while a simple model helps to present the possible mechanisms that governed a certain formal result of nystagmometric examination of the patient.

REFERENCES

Levashov, M. M.; Rodionov, V. D.; and Starostenko, A. M. in Sensornyye sistemy. Vestibulyarnaya funktsiya. Ob'yedin. Nauchn. Sovet "Fiziologiya cheloveka i zhivotnykh" ["Sensory Systems. Vestibular Function. United Scientific Counsel "Physiology of Man and Animals"], USSR Academy of Sciences, Leningrad, 1974, p 15-72.

Kosoy, J. Acta Otolaryngol., 1977, Suppl. 343, p 57.